Behavior as a Tool to Assess the Effects of Developmental Methylmercury Exposure in Zebrafish

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Keywords: behavior, escape response, mercury, selenium, zebrafish

Background: Adult behavioral abnormalities result from methylmercury (MeHg) exposure during sensitive ontogenetic periods. Identifying behaviors that assess MeHg toxicity, neural mechanisms of these effects and treatments (e.g., selenomethionine [SeMet] to reduce those impacts are critical goals of neurobehavioral toxicity research. Zebrafish were used as a biomedical model for postnatal/adult human neurobehavioral toxicity due to developmental MeHg exposure and clinical treatments using SeMet.

Methods: (1) Zebrafish embryos (<2 hours post fertilization; hpf) were exposed to combinations of 0.0–0.30 µM MeHg and/or SeMet until 24 hpf. (2) Eggs from females that were fed MeHg-contaminated walleye (1–3.5 ppm MeHg) for 2 weeks were fertilized by unexposed males. (3) Embryos (24 hpf) were tested for MeHg and SeMet uptake by inductively coupled plasma mass spectroscopy (ICP-MS). (4) Behavioral tests on offspring from waterborne or dietary exposures included vibrational stimuli responses (5-d old), visual responses to a rotating black bar under low light conditions (4-month old), or learning in a spatial alternation paradigm (4-month old).

Results: Embryo MeHg uptake was dose dependent. Only 0.3 µM SeMet affected visual responses; responses to MeHg occurred at all concentrations. Ratios of 1–3 SeMet:1 MeHg induced visual responses similar to controls; dietary exposure reduced responses only at 3.5 ppm MeHg. Reaction time to vibrational stimuli, duration of behavior, and maximum velocity were dose dependent; SeMet co-exposure minimized those effects. MeHg (0.1–0.3 µM) reduced spatial learning performance; lesser reductions occurred at 0.01–0.06 µM MeHg.

Conclusions: Due to similarities to human postnatal/adult behavioral deficits, zebrafish serve as a biomedical model to assess short- and long-term behavioral abnormalities from developmental MeHg exposure. Since behavioral effects of developmental MeHg exposure were reduced by co-exposure to SeMet, such dietary supplements may have clinical importance to human health.

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